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STUDIES OF NEOTROPICAL COMPOSITAE–XI. THE NEW GENERIC NAME *ELECTRANTHERA* (COREOPSIDEAE)

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ABSTRACT

Electranthera Mesfin, Crawford, & Pruski (Compositae: Coreopsideae), a shrubby, pistillate-rayed segregate of typically herbaceous, sterile-rayed *Coreopsis*, is a new generic name and replaces illegitimate *Electra* DC. 1836 (non *Electra* Panz. 1813, Gramineae). Three new combinations at species rank are proposed: ***Electranthera cuneifolia*** (Greenm.) Mesfin, Crawford, & Pruski, **comb. nov.**, ***Electranthera mutica*** (DC.) Mesfin, Crawford, & Pruski, **comb. nov.** (with ten varieties and nine new varietal combinations), and ***Electranthera parvifolia*** (S.F. Blake) Mesfin, Crawford, & Pruski, **comb. nov.** The type locality of *Coreopsis mutica* (≡ *Electranthera mutica*) was given by Keerl as "ad Tlapujahua" [near the Michoacán border with Mexico], but a type locality of somewhere in southern Hidalgo or adjacent Puebla seems more plausible.

Shrubby, pistillate-rayed *Electra* DC. (Compositae: Coreopsideae) was resurrected from synonymy with typically herbaceous, sterile-rayed *Coreopsis* L. by Mesfin Tadesse and Crawford (2014). That *Electra* DC. is an illegitimate later homonym of *Electra* Panz. 1813 (Gramineae), however, has escaped our attention until now. *Electra* Panz. was treated as valid, for example, in Sprengel (1817), Pfeiffer (1874), Jackson (1893), Davidse (2003), and *Index Nominum Genericorum* (Farr et al. 1979). The main purpose of this paper is to propose a new generic replacement name for *Electra* DC., for which we coin the alphabetically adjacent *Electranthera* Mesfin, Crawford, & Pruski.

Candolle (1836) described *Electra* as monotypic and simultaneously also named *Coreopsis mutica* DC. Gray (1852) described a second species of *Electra* and noted that inner disk florets of the genus do not always appear to set seed. Bentham and Hooker (1873) and Hemsley (1881) each treated *Electra* in synonymy with *Coreopsis*. *Electranthera* was treated at sectional rank as *Coreopsis* sect. *Electra* S.F. Blake by Blake (1913, 1917, 1924), Sherff (1936), Sherff and Alexander (1955), Crawford (1970, 1976, 1982), Crawford and Smith (1983), Jansen et al. (1987), and Mesfin Tadesse and Crawford (1995). The floras by Blake et al. (1926) and Turner (2010) treated *Coreopsis* without using infragenera and with *Electra* in synonymy.

Blake (1913, 1917) circumscribed *Coreopsis* sect. *Electra* as containing three species, but Blake (1924) referred additionally Hispaniolan *C. buchii* (Urb.) S.F. Blake to this section. Blake (1913) recognized *C. mexicana* (DC.) Hemsl. but quickly (Blake 1917) reduced it to synonymy with *C. mutica*, thus establishing priority of *C. mutica* over *Electra mexicana*. Sherff (1936) and Sherff

and Alexander (1955) followed Blake (1924) by recognizing these four species in *Coreopsis* sect. *Electra*. *Coreopsis buchii* was excluded from sect. *Electra* by Smith (1975) and Crawford (1976) and more recently treated as the sole species of obviously pappose *Selleophytum* Urb. by Kimball and Crawford (2004), Mort et al. (2008), Mesfin Tadesse and Crawford (2006, 2014), and Pruski (2015).

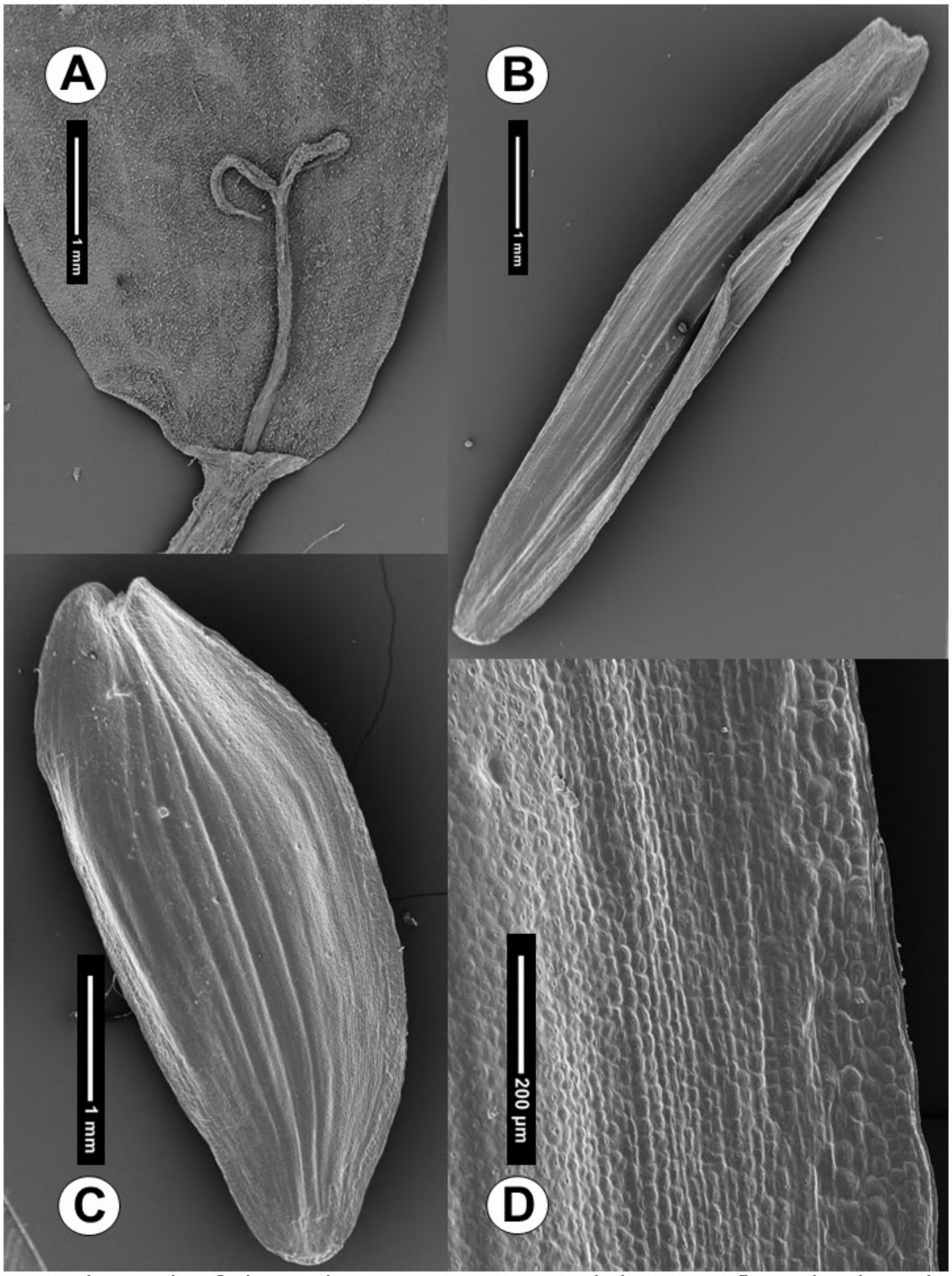

Figure 1. SEM micrographs of *Electranthera mutica* var. *microcephala*. A. Ray floret, showing style and adaxially strongly papillose corolla limb. B. Inner disk cypsela (adaxial view). C. Outer disk cypsela (abaxial view) showing the emarginate apex. D. Outer disk cypsela (close-up of C) on the left and in the center showing Type A (Mesfin Tadesse & Crawford 2014) pericarp surface ornamentation pattern with both radial and tangential walls thickened by unidentified dark secretions and the epidermis surface slightly raised, and on the right the larger cells of the pale narrow lateral margins. (A from *Cronquist 9675*, MO; B–D from *Castillo 1632*, MO; sample preparation method is as given in Pruski 2012).

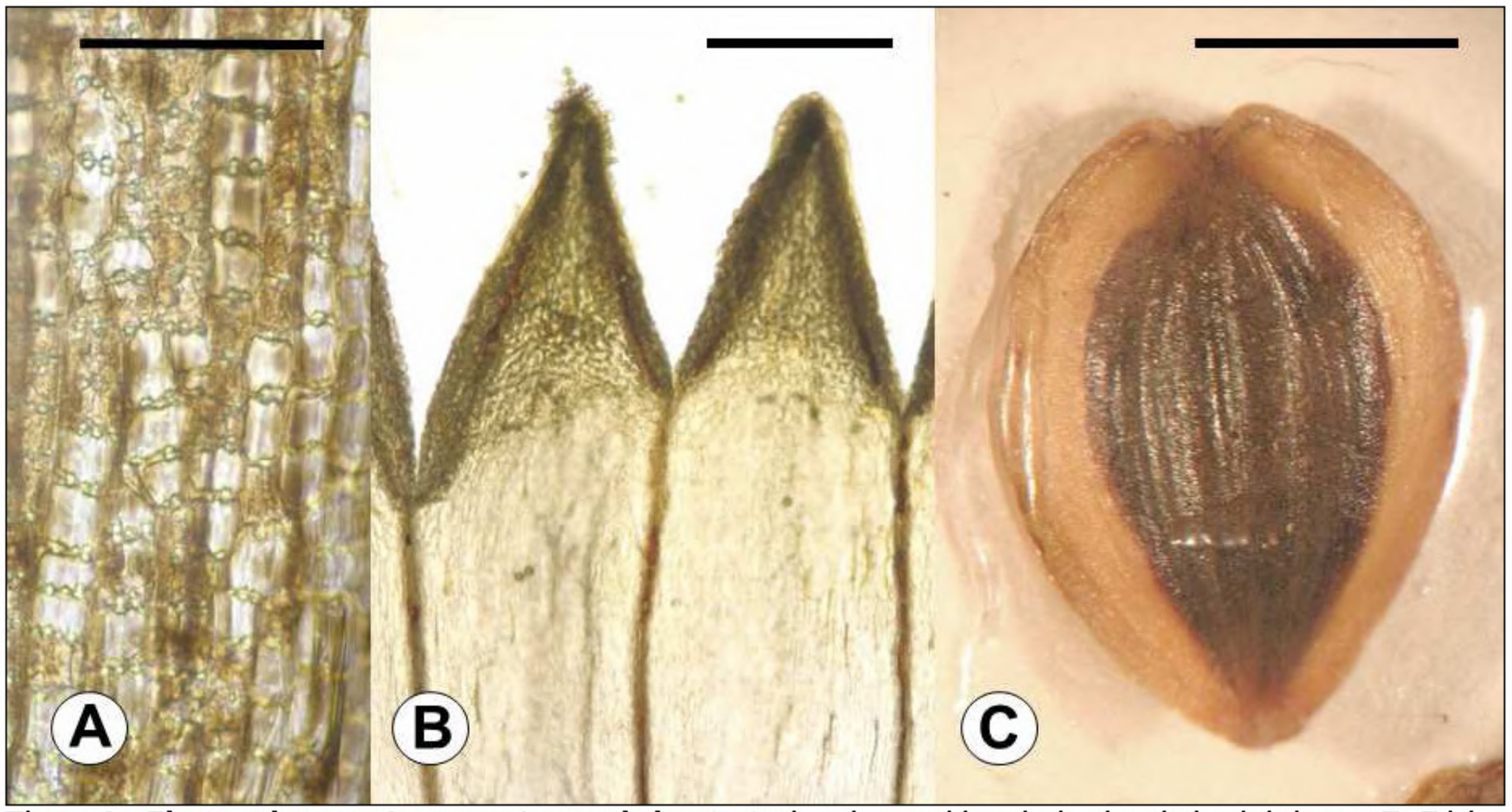

Figure 2. *Electranthera mutica* var. *microcephala*. A. Anther theca with polarized endothecial tissue. B. Disk corolla showing resin ducts single along the veins in the throat. C. Ray cypsela (abaxial view) showing dark but non-carbonized body and thin pale lateral wings. All from *Castillo 1632*, MO. [Scale bars: A 40 µm; B 0.5 mm; C 2 mm].

In resurrecting *Electra* from synonymy with *Coreopsis*, Mesfin Tadesse and Crawford (2014) provided a generic key and noted that *Coreopsis* sect. *Electra* (here *Electranthera*), called *Coreopsis*-1A in their Fig. 5, was not recovered as sister to *Coreopsis* sensu stricto. Their results were in agreement with earlier studies (Kimball et al. 2004, Mort et al. 2008) and support the removal *Electranthera* from *Coreopsis*. Characters used by Candolle (1836), Blake (1913), Sherff (1936), and Mesfin Tadesse and Crawford (2014) to distinguish *Electranthera* (as *Electra* or *Coreopsis* sect. *Electra*) from *Coreopsis* s. str. included its shrubby habit, typically serrate-margined leaves that are never filiform-divided, pistillate ray florets forming fruit (Figs. 1A, 2C), papillose to pilose corolla tubes without a thickened annulus, and strongly flattened, glabrous, obcompressed, non-carbonized cypselae (Figs. 1B–D, 2C). The individual cells of the pericarp epidermis in *Electranthera* have dark secretions on their radial and tangential walls with the epidermis surface slightly raised (Fig. 1D; Type A pericarp surface ornamentation pattern in Mesfin Tadesse and Crawford 2014: Fig. 1C) but are without phytomelanin pegs. Other characters useful in characterizing *Electranthera* include its polarized endothecial tissue typical of Coreopsideae (Fig. 2A) and disk corolla throats with resin ducts single along the veins (Fig. 2B).

In addition to validating *Electranthera* as a replacement name for *Electra* DC. based on the taxonomy of Mesfin Tadesse and Crawford (2014), we propose three new specific and nine new varietal combinations in the genus. We also provide a synopsis of *Electranthera*, supplementing the fine treatments of Sherff (1936), Sherff and Alexander (1955), Crawford (1970, 1981, 1982), Turner (2010), and Mesfin Tadesse and Crawford (2014). We note that Western naming conventions and surnames are not used traditionally in Ethiopia. For example, one of us (Mesfin Tadesse) uses his given name of Mesfin followed by the patronym Tadesse, his name used by IPNI is Mesfin, and his name is spelled in full in literature citations and indexed by the first element.

ELECTRANTHERA Mesfin, Crawford, & Pruski, **nom. nov.** *Electra* DC., Prodr. 5: 630. 1836 (non *Electra* Panz., Ideen Revis. Gräs. 49. 1813, Gramineae). *Coreopsis* sect. *Electra* S.F. Blake, Proc. Amer. Acad. Arts 49: 337. 1913. [the intended sectional comb. nov. by Blake is to be taken as a nom. nov., fide Article 58.1 of the Code]. **TYPE**: *Electra mexicana* DC. [≡ *Electranthera mutica* var. *mexicana* (DC.) Mesfin, Crawford, & Pruski].

Subshrubs to shrubs; stems leafy, leaves more or less evenly distributed distally along branches; herbage eglandular. **Leaves** opposite throughout, undivided to tripartite, sessile to petiolate; blade or blade segments lanceolate to ovate, chartaceous to subcoriaceous or somewhat carnose, venation pinnate, surfaces eglandular, usually glabrous or lightly pubescent to less commonly hirsute or villous, margins serrate or dentate to very rarely entire. **Capitulescence** terminal, open, of several branches each corymbiform-paniculate or with a solitary terminal capitulum, often moderately exserted from subtending leaves on elongate peduncles. **Capitula** radiate, moderately showy; involucre double; phyllaries 2-seriate, dimorphic, unequal to sometimes nearly subequal, more or less planar, free to base; outer phyllaries 4–6, oblanceolate or spatulate to obovate, herbaceous, green, spreading; inner phyllaries ca. 8, usually longer than the outer, more or less ovate-oblong, thin-chartaceous with scarious margins, pluristriate, yellowish with darker striations; clinanthium flat, paleate; paleae flat, few-striate, resin ducts paired, deciduous. **Ray florets** 5–8(–11), pistillate (Fig. 1A); corolla yellow throughout, without dark blotches proximally on limb, tube short, papillose to pilose, limb oblong to elliptic, never obovate-cuneate, 7–15-nerved, resin ducts single long nerves, adaxial surface papillose (Fig. 1A), apex evenly (never obviously irregularly) 2–3(–5)-dentate; style well-exserted. **Disk florets** bisexual, but the innermost sometimes not setting seed; corolla funnelform-campanulate, yellow, (4–)5-lobed, tube usually shorter than to sometimes about as long as throat, papillose to pilose, base not flaring, without a thickened annulus, throat with resin ducts single along veins (Fig. 2B), lobes much shorter than throat, strongly papillose within; anther thecae dark brown to black, filaments glabrous, endothecial pattern polarized (Fig. 2A), collar longer than basal auricles, apical appendage mostly tan but sometimes with proximal central dark resin canal; style branches flattened, appendiculate, stigmatic surfaces (moderately) 2-banded, appendage short cuspidate-subulate or caudate; nectary tubular or narrowly cylindrical. **Cypselae** strongly obcompressed (Figs. 1B–D, 2C), flat to somewhat incurved, erostrate, graduated monomorphic or slightly heteromorphic with ray cypselae and outer disk cypselae broadly elliptic to broadly ovate or obovate in outline, grading to successively longer and narrower inner disk cypselae, these lanceolate or linear-fusiform and sometimes not always setting seed, all cypselae narrow-margined or thinly and narrowly winged, glabrous throughout, faces brown to grayish-black at maturity, nitidous, few-several costate but otherwise smooth, never tuberculate roughened, pericarp surface pattern Type A with the individual cells with dark secretions on their radial and tangential walls (Fig. 1D; Mesfin Tadesse and Crawford 2014: Fig. 1C), but without phytomelanin pegs, base broad-rounded with an inconspicuous carpopodium, carpopodium never thickly globose-calloused (thus not resembling tickseeds), margins entire, stramineous or brown, apex emarginate; all epappose or some inner cypselae very infrequently with a pair of small slender awns. x = 14.

Electranthera is centered in the highlands of Mexico and contains the same three species recognized in *Electra* by Mesfin Tadesse and Crawford (2014): diploid cuneate-leaved *E. cuneifolia*, octoploid small-leaved *E. parvifolia*, and the tetraploid or octoploid (and perhaps occasionally hexaploid) mostly linear-lanceolate to ovate-leaved plants that constitute the remaining bulk of the genus, which we recognize as *E. mutica* and within which we recognized ten moderately distinct varieties. Although, Turner (2010) elevated *E. mutica* var. *multiligulata* to specific rank, we find that this variety falls within our admittedly broad concept of *E. mutica*.

Key to species of *Electranthera*

1. Leaves undivided to 3-parted to near midrib, blades (3–)4–16 cm long, blades or blade segments linear-lanceolate to ovate (when ovate then ≥ 3 cm long); capitulescences usually 5–40+-capitulate, corymbiform-paniculate to open-cymose or infrequently monocephalous; tetraploids or octoploids with $2n = 4x = 56$ or $2n = 8x = 112$, never diploids ..... 2. **Electranthera mutica**
1. Leaves undivided, blades mostly 1–4(–5) cm long, cuneate to oblanceolate or ovate (when ovate then ≤ 2.5 cm long) to orbicular; capitulescences monocephalous to paucicephalous open-cymose; diploids or octoploids with $2n = 2x = 28$ or $2n = 8x = 112$, never tetraploids.

    2. Leaf blades cuneate to oblong or oblanceolate; subshrubs or shrubs 0.5–1 m tall; capitula 14–30 mm wide across the extended rays; southern Durango and Jalisco, Mexico; diploids with $2n = 2x = 28$ ..... 1. **Electranthera cuneifolia**
    2. Leaf blades ovate to orbicular; shrubs mostly 1–3 m tall; capitula 25–45 mm wide across the extended rays; eastern Puebla and west-central Veracruz, Mexico; octoploids with $2n = 8x = 112$ ..... 3. **Electranthera parvifolia**

1. **ELECTRANTHERA CUNEIFOLIA** (Greenm.) Mesfin, Crawford, & Pruski, **comb. nov.** *Coreopsis cuneifolia* Greenm., Proc. Amer. Acad. Arts 40: 43. 1904. *Electra cuneifolia* (Greenm.) Mesfin & Crawford, Nord. J. Bot. 32: 88. 2014 [2013]. **LECTOTYPE** (as to collection by Blake et al. 1926: 1587; second step sheet designation by Sherff 1936: 301): **MEXICO. Durango.** Without specific locality, 16 Aug 1897, *Rose 2344* (lectotype: GH; isolectotype: US). McVaugh (1984: 256) cited US as the lectotype sheet. Figure 3.

Subshrubs or shrubs 0.5–1 m tall; stems few-branched, sparsely villosulous to villous at the nodes, otherwise glabrate; internodes as seen on herbarium specimens often about as long as or shorter than the leaves. **Leaves** undivided, subsessile to petiolate; petiole 0.1–0.5 cm long; blade mostly 1–4(–5) × 0.5–2(–2.5) cm, cuneate to oblong or oblanceolate, subcoriaceous to somewhat carnose, secondary veins usually 2–4(–5) per side, surfaces glabrous or sometimes sparsely puberulent, base narrowly cuneate to long-acuminate, margins distally few-serrate, teeth 1–5 per side, 1–2 mm long, spreading, apex usually acute. **Capitulescence** monocephalous to paucicephalous open-cymose; peduncles 5–20 cm long, costate-angulate. **Capitula** 8–11 mm tall, 14–30 mm wide across the extended rays; involucre 5–10 mm long, campanulate; outer phyllaries 4–5, 3–6.5 × 1.2–1.7 mm, narrowly oblong, much narrower than and ca. 1/2–3/4 as long as inner phyllaries, appressed to slightly spreading, subcarnose, green, 3-nerved, lateral nerves submarginal, glabrous, not contiguous at base, apex acute to obtuse; inner phyllaries 5–10 × 3–3.8 mm, obovate, scarious, yellowish with 7–9 dark nerves, margins pale-hyaline, apex broadly acute to obtuse; paleae ca. 10 mm long, linear-lanceolate, 3-nerved, glabrous, apex broadly acute. **Ray florets** usually 5(–6); corolla limb 6–15 mm long, obovate to suborbicular, 8–12-nerved, apical teeth to 2 mm long. **Disk florets** 15–25(–30); corolla 4.3–4.8 mm long, lobes ca. 0.9 mm long; anthers ca. 2 mm long; style branches ca. 1.3 mm long, sterile appendage 0.3–0.4 mm long. **Cypselae** 6–9 × 3–5.5 mm, broadly elliptic to obovate in outline; epappose or infrequently a few inner ones with 2 narrow fragile awns about as long as disk corollas.

Representative collections. **MEXICO. Durango.** *Rose 2344* (lectotype collection: GH, US). **Jalisco.** *Barnes & Land 165* (F, MO); *Melchert et al. 6358* (MO, OS); *Pringle 8781* (syntype collection: CM, E, GH, GOET, K, MEXU-4, MIN, MO, NY, P, PH, S, VT); *Pringle 11900* (F, GH).

Distribution, elevation, and chromosome number. *Electranthera cuneifolia* is known only from southern Durango and Jalisco in western Mexico (as mapped by Turner 2010: 154, map 33), where it occurs mostly in oak forests from 1500–1800 meters elevation; diploid, $2n = 2x = 28$.

This is the only species of *Electranthera* treated by McVaugh (1984) in Nueva Galicia.

Figure 3. Syntype of *Coreopsis cuneifolia* (≡ *Electranthera cuneifolia*) (*Pringle 8781*, MO).

2. ELECTRANTHERA MUTICA (DC.) Mesfin, Crawford, & Pruski, **comb. nov.** *Coreopsis mutica* DC., Prodr. 5: 571. 1836. *Electra mutica* (DC.) Mesfin & Crawford, Nord. J. Bot. 32: 88. 2014 [2013]. **TYPE: MEXICO.** Ad Tlapujahua [precise locality uncertain, perhaps Hidalgo?, Michoacán border with Mexico?, or Puebla?], comm. 1829, *Keerl s.n.* (holotype: BR-MART; isotypes: F, G-DC p.p.). The G-DC isotype is a labeled packet on the bottom of the sheet, as well as a branchlet matching the BR branchlets. The F fragment from G-DC is presumably from this packet and is an isotype of the typical variety. Mesfin Tadesse and Crawford (2014: 88) cited G-DC as the lectotype specimen, but this conflicts with Candolle's protologue that gave "v.s. in h. Mart." Indeed, Sherff (1936) cited correctly the holotype in the personal Martius herbarium now housed in the Botanic Garden in Meise, cited by us as BR-MART.

Turner (1992) noted that Keerl's place name Tlapujahua is in extreme eastern Michoacán (less than 10 km west of border with Edo. Mexico), but the species is otherwise unknown in the environs of Tlapujahua. Sherff (1936) and Mesfin Tadesse and Crawford (2014) interpreted the Keerl place name as Tlapacoya, Puebla, a locality about 250 km east of Tlapujahua, Michoacán, but the species is otherwise unknown from near Tlapacoya in north-central Puebla. Sherff and Alexander (1955) gave (incorrectly) the type locality as "Tlapehula, Guerrero?" but only one rare non-typical endemic variety is known from Guerrero. Because the species appears unknown or at best very rare near Tlapujahua (Michoacán border with Mexico), Tlapacoya (Puebla), and Tlapehula (Guerrero), it seems possible that Keerl's plants may have come from elsewhere. Indeed, based on the specimens in front of us and the exsiccate citations and maps in Crawford (1970, 1981) it seems plausible that Keerl's plants may be from southern Hidalgo (or adjacent Puebla), where *E. mutica* var. *mutica* sensu Crawford (1970, 1981) is centered.

Shrubs 0.3–5 m tall; stems branched, mostly subglabrous to densely pilose or villous. **Leaves** undivided to 3-parted to near midrib, petiolate or distal ones subsessile; petiole 0.5–3 cm long, narrowly margined distally; blade (3–)4–16 × 1–6 cm, blade or blade segments linear-lanceolate to ovate, thin chartaceous to subcarnose or stiff-chartaceous, usually with several evenly spaced secondary veins, adaxial surface glabrous or subglabrous to infrequently pilose-hirsute, abaxial surface glabrous to occasionally villous especially along larger veins, base attenuate with short basal acumen to cuneate or infrequently somewhat rounded, margins serrate very infrequently subentire, apex acute to acuminate or attenuate. **Capitulescence** usually 5–40+-capitulate, corymbiform-paniculate to open-cymose or infrequently monocephalous, fertile branchlets bracteate, bracts 0.4–1.5+ cm long; peduncles 1–10 cm long, slender. **Capitula** 6–17 mm tall, 20–50 mm wide across extended rays; involucre 6–12 mm long, campanulate or narrowly so; outer phyllaries 4–6, 5–12 × 1–2.5 mm, oblanceolate to obovate, glabrous throughout to villous or margins sometimes ciliate, apex narrowly acute to broadly obtuse, more or less mucronulate; inner phyllaries 5–7(–8), 8–12 mm long, oblong to elliptic or broadly ovate, golden-brown with stramineous margins, dark pluristriate with yellow intercostae very narrow; paleae (6–)8–11 mm long, narrower than inner phyllaries, usually reaching to about middle of corolla throat, narrowly oblanceolate, 3–7-striate, apex acute to obtuse. **Ray florets** 5–8(–11); corolla limb 10–20 × (4–)6–12 mm, elliptic to obovate, 7–15-nerved. **Disk florets** 10–20; corolla 5–7.5 mm long, resin canals of throat dark but sometimes drying with a very thin pale central streak, lobes usually 0.9–1.3 mm long; anthers 2.5–4 mm long; style branches 1.5–2 mm long, sterile appendage 0.3–0.7 mm long. **Cypselae** 5–10(–13) mm long, broadly ovate or elliptic in outline to inner ones sometimes linear-fusiform; epappose or rarely inner ones with 2 small vestigial awns.

Representative collections. Supplementing the below cited type specimens of each variety, respectively, are additional specimen citations as given in Crawford (1970, 1981) and Turner (1992, 1996).

Distribution, elevation, and chromosome numbers. *Electranthera mutica* is centered in Mexico, with only the very common *E. mutica* var. *microcephala* occurring southwards into Central America. Distribution maps for most varieties were provided by Crawford (1970, 1981) and Turner (1992, 2010), showing that six of the ten varieties occur in Oaxaca. The species occurs mostly in montane forests, oak forests, pine-oak forests, and thickets, on dry hillsides, roadside banks, wooded slopes, and along stream sides from (400–)700–2800 meters elevation with flowering concentrated between June and January. The species contains varieties that are either tetraploid or octoploid ($2n = 4x = 56$ or $2n = 8x = 112$; and perhaps an occasional hexaploid with $2n = 6x =$ ca. 84), varieties of the same ploidy level are for the most part allopatric and reproductively isolated in nature but capable of being crossed artificially. For example, Crawford (1972) showed that octoploids *E. mutica* var. *carnosifolia* and *E. mutica* var. *subvillosa* may be crossed. Chromosome numbers and ploidy levels are unknown in three of the varieties.

Sherff (1936) and Sherff and Alexander (1955) each recognized four varieties. We recognize the seven varieties of Crawford (1970) plus another three varieties proposed subsequently by Crawford (1981) and Turner (1992, 1996). Eight of the following ten varieties were recognized under *Electra mutica* by Mesfin Tadesse and Crawford (2014). Of the ten varieties of *E. mutica* we recognize, perhaps *E. mutica* var. *guerreroana* by its undivided entire leaves is the least mainstream. However, *E. mutica* var. *guerreroana* too is provisionally retained within *E. mutica* with the caveat that should it prove to be diploid it would be worthy of specific recognition. Thus in our present concept of *Electranthera*, all material except for infrequently encountered diploid, cuneate-leaved *E. cuneifolia* and octoploid small-leaved *E. parvifolia* falls within tetraploid to octoploid *E. mutica*.

Keys to the varieties of *Electranthera mutica* were provided by Crawford (1970) and Turner (1992, 2010). Crawford's first couplet was based on leaf division, whereas the keys by Turner did not place the same emphasis on this character. We also find leaf division the most useful primary character for conceptualizing infrataxa, and following Crawford (1970) we note that four varieties (vars. *holotricha*, *leptomera*, *mutica*, and *subvillosa*) typically have at least some leaves 3-parted. Among these four 3-parted-leaved varieties, indumentum features serve to diagnose *E. mutica* var. *holotricha* (leaves usually less than 4 cm long, pubescent adaxially) and *E. mutica* var. *subvillosa* (capitulescence branches villous or subvillous), whereas *E. mutica* var. *leptomera* is the only known tetraploid and has terminal lanceolate leaf segments.

The six varieties that are strictly undivided-leaved are *E. mutica* vars. *carnosifolia*, *guerreroana*, *mexicana*, *miahuatlana*, *microcephala*, and *multiligulata*. Although *E. mutica* is usually circumscribed in part by it pluricephalous capitulescences, four of the undivided-leaved varieties (vars. *carnosifolia*, *guerreroana*, *mexicana*, and *multiligulata*) are paucicephalous or even monocephalous. Among the four paucicephalous undivided-leaved varieties, only *E. mutica* var. *guerreroana* has entire-margined leaves. *Electranthera mutica* var. *multiligulata* is diagnosed by its large capitula each with 8–11 ray florets, vs. the usual 5–8-rayed condition of the other nine varieties of *E. mutica* and of the two other species of *Electranthera*. When chromosome numbers and ploidy levels are known, the undivided-leaved varieties of *E. mutica* are generally tetraploids, with *E. mutica* var. *carnosifolia* standing out as the only known octoploid. The two pluricephalous undivided-leaved varieties of *E. mutica* recognized by us (*E. mutica* vars. *miahuatlana* and *microcephala*) are very similar, and *E. mutica* var. *miahuatlana* by its relatively large capitula is recognized by us as distinct from *E. mutica* var. *microcephala*.

The ten varieties of *E. mutica* that we recognize are as follows.

2A. ELECTRANTHERA MUTICA var. **CARNOSIFOLIA** (Crawford) Mesfin, Crawford, & Pruski, **comb. nov.** *Coreopsis mutica* var. *carnosifolia* Crawford, Brittonia 22: 110. 1970. *Electra mutica* var. *carnosifolia* (Crawford) Mesfin & Crawford, Nord. J. Bot. 32: 88. 2014 [2013]. **TYPE: MEXICO. Oaxaca.** Hwy 190, km 689–690, 15.8 mi NW of bridge over Río Hondo and 40.6 mi SE of Totolapan, 15 Sep 1967, *Melchert, Crawford & Averett 67-86* (holotype: IA; isotypes: OS, RM).

Distribution, elevation, and chromosome number. Mexico (Oaxaca; mapped by Crawford 1970: 99, fig. 1); moderately common between (400–)1600–2500 meters elevation; octoploid, $2n = 8x = 112$.

Electranthera mutica var. *carnosifolia* has undivided leaves drying resin-streaked thereby resembling *E. mutica* var. *guerreroana*. Crawford (1972) noted that populations of suspected hybrids between *E. mutica* vars. *carnosifolia* and *subvillosa* occur at about 1500 meters elevation near the city of Oaxaca. Some material from low elevations west of Tehuantepec along the Pacific slope of Oaxaca resembles *E. mutica* var. *multiligulata* by its few-capitulate distal branches but never has 11 rays per capitulum.

2B. ELECTRANTHERA MUTICA var. **GUERREROANA** (B.L. Turner) Mesfin, Crawford, & Pruski, **comb. nov.** *Coreopsis mutica* var. *guerreroana* B.L. Turner, Phytologia 73: 7. 1992. **TYPE: MEXICO. Guerrero.** 6 km E of Chatacachapa, a village between Chilapa and Tixtla along the road to Chilpancingo, 1900 m, 4 Sep 1991, *Panero 2281* (holotype: MEXU; isotypes: MEXU, MICH, TEX, US).

Distribution, elevation, and chromosome number. Mexico (Guerrero; mapped by Turner 2010: 155, map 36), known only from near the type locality; ca. 1500 meters elevation; chromosome number unknown.

We suspect this taxon may prove to be either a tetraploid or an octoploid and thus provisionally retain it at the varietal rank. It stands out, however, as the sole taxon of *Electranthera* with entire-margined leaves. Should the distinctive *E. mutica* var. *guerreroana* prove to be a diploid taxon, however, it would merit specific recognition.

2C. ELECTRANTHERA MUTICA var. **HOLOTRICHA** (S.F. Blake) Mesfin, Crawford, & Pruski, **comb. nov.** *Coreopsis mexicana* fo. *holotricha* S.F. Blake, Proc. Amer. Acad. Arts 49: 338. 1913. *Coreopsis mutica* var. *holotricha* (S.F. Blake) S.F. Blake, Proc. Amer. Acad. Arts 52: 55. 1917. **TYPE: MEXICO. Puebla.** Vicinity of San Luis Tultitlanapa, Jul 1908, *Purpus 3099* (holotype: GH; isotypes: F, MO, NY, UC, US).

Distribution, elevation, and chromosome number. Mexico (Oaxaca, Puebla; mapped by Crawford 1970: 99, fig. 1); uncommon between 1800–2400 meters elevation; chromosome number unknown.

Mesfin Tadesse and Crawford (2014) intended to validate a new combination in *Electra mutica* for this variety but did not cite the basionym *C. mexicana* fo. *holotricha*. Both leaf surfaces of this taxon are moderately to densely pubescent.

2D. ELECTRANTHERA MUTICA var. **LEPTOMERA** (Sherff) Mesfin, Crawford, & Pruski, **comb. nov.** *Coreopsis mutica* var. *leptomera* Sherff, Bot. Gaz. 88: 300. 1929. *Electra mutica* var. *leptomera* (Sherff) Mesfin & Crawford, Nord. J. Bot. 32: 88. 2014 [2013]. **TYPE: MEXICO.**

Hidalgo. Dublan, 6800 ft. [= 2070 m], 15 Oct 1902, *Pringle 9895* (holotype: F; isotypes: B, CM, GH, JE, MO, NY, US).

Silphium ternatum Sessé & Moc., non Willd.

Distribution, elevation, and chromosome number. Mexico (Hidalgo, Jalisco, Mexico, Queretaro; mapped by Crawford 1970: 99, fig. 1, but Guanajuato localities now excluded as in Crawford 1981: 550, fig. 2; nevertheless to be looked for in Guanajuato and northern Michoacán, where Rzedowski and Calderón de Rzedowski (2008) and Turner (2010) listed a broadly defined *E. mutica* var. *mutica* as occurring; the Sessé and Mociño type locality of synonymous *S. ternatum* given as "Tuxtlae montibus" is not known to us, and although McVaugh (2000) suggested it is San Andrés Tuxtla, Veracruz, this is unlikely because the species is otherwise not reported from there); occasional between 1800–2200 meters elevation; tetraploid, $2n = 4x = 56$.

We follow the taxonomy of Crawford (1970) as modified by Crawford (1981), and recognize a narrowly defined tetraploid *E. mutica* var. *leptomera* as distinct from both *E. mutica* var. *mexicana* and the more eastern *E. mutica* var. *mutica* by typically 3-parted leaves with narrowly lanceolate terminal segments.

2E. ELECTRANTHERA MUTICA var. **MEXICANA** (DC.) Mesfin, Crawford, & Pruski, **comb. nov.**
Electra mexicana DC. [var. *mexicana*], Prodr. 5: 630. 1836 (autonym and varietal priority established by Blake 1913 upon naming of *C. mexicana* var. *hyperdasya*). *Coreopsis mexicana* (DC.) Hemsl. Biol. Cent.-Amer., Bot. 2: 196. 1881. **LECTOTYPE** (designated as to collection by Crawford 1981): **MEXICO. Guanajuato.** Villalpando, 1829, *Mendez & Alaman s.n.* (lectotype, sheet designation made here): G-DC, IDC microfiche 800. 965.I.2, Macbride neg. 33770; presumed isolectotypes: G-DC 2-sheets, GH [the G-DC isotypes are on IDC microfiche 800. 965.I.3 and 965.I.4]). The branches of the lectotype sheet are positioned differently in the microfiche than on the earlier Macbride photograph. The two presumed isolectotypes in G-DC are without collection information, but in the microfiche set they follow immediately the labeled lectotype. The collection information on the GH sheet is in the hand of Asa Gray. Second cited syntype collection: *Nee s.n.* (not seen).

Coreopsis mutica var. *simplicifolia* Crawford, *Electra mutica* var. *simplicifolia* (Crawford) Mesfin & Crawford.

Distribution, elevation, and chromosome number. Mexico (Guanajuato; mapped by Crawford 1981: 550, fig. 2 under the name *C. mutica* var. *simplicifolia*); uncommon narrow endemic at about 2100–2200 meters elevation; tetraploid, $2n = 4x = 56$.

Blake (1917) and Blake et al. (1926) treated *Coreopsis mexicana* (i.e., var. *mexicana*, priority established in 1913) in synonymy with the typical variety of *C. mutica*, whereas Sherff (1936), Sherff and Alexander (1955), and Crawford (1970) treated *C. mexicana* [var. *mexicana*] in synonymy with *C. mutica* var. *leptomera* (1929). Crawford (1970) also provisionally included material from Guanajuato in his concept of *C. mutica* var. *leptomera*. Rzedowski and Calderón de Rzedowski (2008) and Turner (1992, 2010) treated both *Electra mexicana* and *C. mutica* var. *simplicifolia* in taxonomic synonymy with octoploid *C. mutica* var. *mutica*. Crawford (1981) excluded undivided-leaved material from Guanajuato from *C. mutica* var. *mutica*, described this material as *C. mutica* var. *simplicifolia*, and treated heterotypic *C. mexicana* [var. *mexicana*] in taxonomic synonymy with it.

Validation by Blake (1913) of heterotypic *Coreopsis mexicana* var. *hyperdasya* S.F. Blake (a synonym of *E. mutica* var. *subvillosa*), however, established *C. mexicana* var. *mexicana*, the priority

of this autonym thereby dated 1913 as well (viz Article 26.3 of the Code; Turner 1992: 10). Here we follow the taxonomy of Crawford (1981) and thus employ the autonym *C. mexicana* var. *mexicana*, which has priority at varietal rank as the basionym of *E. mutica* var. *mexicana*. We note, however, that while Mesfin Tadesse and Crawford (2014) proposed the name *Electra mutica* var. *simplicifolia* for this taxon, they did not list *Electra mexicana* in synonymy. Tetraploid *E. mutica* var. *mexicana* differs from both octoploid E. *mutica* var. *mutica* and tetraploid *C. mutica* var. *leptomera* by strictly undivided (vs. at least some 3-parted) leaves.

Electranthera mutica var. microcephala
(Crawford) Mesfin, Crawford & Pruski
det. John Pruski (MO), 2014 (PARATYPE)
Taxonomic Studies in the Coreopsidinae
Herbarium of The University of Iowa
Coreopsis mutica DC.
var. microcephala Crawford 1969
Daniel J. Crawford
HERBARIUM OF
THE NEW YORK BOTANICAL GARDEN
PLANTS OF MEXICO
Coreopsis mutica DC.
CHIAPAS: In brush along the roadside in oak-forest zone on limestone mountains; Pan-American highway about 21 road miles east of Tuxtla Gutierrez. Elevation about 3500 feet.
Sprangling shrub 2-3 m. tall. Heads yellow, with mostly 5 rays.
ARTHUR CRONQUIST 9675
October 15, 1962
MISSOURI BOTANICAL GARDEN
1795169
HERBARIUM
MISSOURI BOTANICAL GARDEN
copyright reserved
cm

Figure 4. Paratype of *Coreopsis mutica* var. *microcephala* (≡ *Electranthera mutica* var. *microcephala*) (*Cronquist 9675*, MO).

2F. ELECTRANTHERA MUTICA var. **MIAHUATLANA** (B.L. Turner) Mesfin, Crawford, & Pruski, **comb. nov.** *Coreopsis mutica* var. *miahuatlana* B.L. Turner, Phytologia 80: 293, fig. 1. 1996. **TYPE: MEXICO. Oaxaca.** Mpio. Miahuatlán, IRF Río Magdalena, Santo Domingo, 2240 m, 4 Aug 1996, *Hinton et al. 26724* (holotype: TEX; isotypes: CIIDIR, GBH, IEB).

Distribution, elevation, and chromosome number. Mexico (Oaxaca; mapped by Turner 2010: 155, map 35); a narrow endemic known from a few collections between 2200–2800 meters elevation; chromosome number unknown.

Although we recognize this variety, further collections may help to better distinguish it from *Electranthera mutica* var. *microcephala*, to which it seems uncomfortably similar, differing primarily by its larger capitula.

2G. ELECTRANTHERA MUTICA var. **MICROCEPHALA** (Crawford) Mesfin, Crawford, & Pruski, **comb. nov.** *Coreopsis mutica* var. *microcephala* Crawford, Brittonia 22: 109. 1970. *Electra mutica* var. *microcephala* (Crawford) Mesfin & Crawford, Nord. J. Bot. 32: 88. 2014 [2013]. **TYPE: MEXICO. Chiapas.** ca. 4 m E of Trinitaria along Route 190, 23 Sep 1966, *Melchert, Sorensen, & Crawford 6453* (holotype: IA; isotype: RM). Figures 1, 2, 4.

Distribution, elevation, and chromosome number. Mexico (Chiapas, Oaxaca) Guatemala, Honduras, El Salvador; mapped by Crawford 1970: 99, fig. 1, we have seen no material from Oaxaca as cited by Turner 2010, but *Breedlove 31451* from Chiapas was collected within 5 km of the border with Oaxaca; fairly common between 800–2400 meters elevation; tetraploid, $2n = 4x = 56$.

Central American material was historically treated within the octoploid typical variety (e.g., Blake et al. 1926; Sherff 1936; Sherff and Alexander 1955) but more recently has been recognized as *E. mutica* var. *microcephala* (e.g., Crawford 1970; Nash and Williams 1976; Strother 1999; Turner 1992, 2010; Mesfin Tadesse and Crawford 2014), a tetraploid taxon.

2H. ELECTRANTHERA MUTICA var. **MULTILIGULATA** (Crawford) Mesfin, Crawford, & Pruski, **comb. nov.** *Coreopsis mutica* var. *multiligulata* Crawford, Brittonia 22: 110. 1970. *Coreopsis multiligulata* (Crawford) B.L. Turner, Phytologia Mem. 15: 75. 2010. *Electra mutica* var. *multiligulata* (Crawford) Mesfin & Crawford, Nord. J. Bot. 32: 88. 2014 [2013]. **TYPE: MEXICO. Oaxaca.** Highway 190, 42 mi W of Tehuantepec, 24 Sep 1966, *Melchert, Sorensen, & Crawford 6469* (holotype: IA; isotypes: OS, RM).

Distribution, elevation, and chromosome number. Mexico (Oaxaca; mapped by Crawford 1970: 99, fig. 1); uncommon narrow endemic from 700–1100 meters elevation; tetraploid, $2n = 4x = 56$.

Electranthera mutica var. *multiligulata* was recognized by Turner (2010) at specific rank but falls within our concept of *E. mutica*, where it is retained at varietal rank. Turner characterized this variety as occurring up to 2200 meters elevation, but we determine material from this elevation as *E. mutica* var. *carnosifolia*. Indeed, tetraploid *E. mutica* var. *multiligulata* seems most similar to octoploid nearly sympatric *E. mutica* var. *carnosifolia*, which differs by having twice the chromosome compliment, often open-cymose (vs. monocephalous) capitulescences, and 8–11-rayed capitula.

2I. ELECTRANTHERA MUTICA (DC.) Mesfin, Crawford, & Pruski var. **MUTICA.**

Distribution, elevation, and chromosome number. Mexico (Hidalgo, México, Michoacán border with Mexico, Puebla; mapped by Crawford 1970: 99, fig. 1; Crawford 1981: 550, fig. 2; Turner 2010: 155, map 36 mapped his broadly defined *E. mutica* var. *mutica* in both Guerrero and Oaxaca, but we have seen no material of *E. mutica* var. *mutica* s. str. from either state); occasional between 2000–2700 meters elevation; octoploid, $2n = 8x = 112$.

Blake (1917), Blake et al. (1926), Sherff (1936), and Sherff and Alexander (1955) each treated *Coreopsis galeottii* in synonymy with the nominate variety, but we follow the taxonomy of Sherff (1936) and Crawford (1970) and treat that name as a synonym of *E. mutica* var. *subvillosa.* Blake (1917), Blake et al. (1926), and Turner (1992, 2010) each treated *C. mexicana* in synonymy with *C. mutica* var. *mutica*, whereas we recognize this undivided-leaved plant as *E. mutica* var. *mexicana*, which is endemic to Guanajuato. The Central American material was treated by Blake et al. (1926) and cited by Sherff (1936) as *C. mutica* var. *mutica* but was described by Crawford (1970) as *C. mutica* var. *microcephala.*

As noted above in the typology of *Electranthera mutica*, the precise protologue type locality of "ad Tlapujahua" (eastern Michoacán on the border with Mexico) is in question. Similarly, Sherff's (1936) interpretation of the type locality of Tlapacoya (Puebla) and the Sherff and Alexander (1955) query of it as being Tlapehula (Guerrero) also reflect uncertainly. We suggest the type locality is from southern Hidalgo (or adjacent Puebla), where Crawford (1970, 1981) mapped this variety as being centered. Although *E. mutica* var. *leptomera*, which also occurs in part in the states of Hidalgo and México, was treated by Turner (1992, 2010) in synonymy with the typical variety, *E. mutica* var. *mutica* differs from it by broader terminal leaf segments. Moreover, the two are disjunct, with *E. mutica* var. *mutica* s. str. occurring only to the east of the range of *E. mutica* var. *leptomera* (Crawford 1981: 550, fig. 2).

2J. ELECTRANTHERA MUTICA var. **SUBVILLOSA** (DC.) Mesfin, Crawford, & Pruski, **comb. nov.**
Coreopsis mutica var. *subvillosa* DC., Prodr. 5: 571. 1836. *Electra mutica* var. *subvillosa* (DC.) Mesfin & Crawford, Nord. J. Bot. 32: 89. 2014 [2013]. **TYPE: MEXICO.** Without specific locality, s.d., *Karwinski s.n.* (holotype: M, Macbride neg. 20711; isotype: G-DC p.p., upper packet).

Coreopsis galeottii (A. Gray) Hemsl., *Coreopsis mexicana* var. *hyperdasya* S.F. Blake, *Electra galeottii* A. Gray.

Distribution, elevation, and chromosome number. Mexico (Oaxaca, Puebla; mapped by Crawford 1970: 99, fig. 1; material cited by Sherff 1936: 299 from Hidalgo has been excluded); moderately common between 1800–2600 meters elevation; octoploid, $2n = 8x = 112$. Turner (1992) reported a count of $2n = 6x =$ ca. 84 for this variety, the only hexaploid we find reported in the genus, but we have not seen Turner's voucher (*Turner 80A-9*, TEX).

We follow Blake (1917), Blake et al. (1926), Sherff (1936), Sherff and Alexander (1955), and Crawford (1970), who synonymized *Coreopsis mexicana* var. *hyperdasya* under *C. mutica* var. *subvillosa.* Blake (1917) and Blake et al. (1926) treated *C. galeottii* in synonymy with the typical variety of *C. mutica*, but we follow instead Sherff (1936) and Crawford (1970) and treat *C. galeottii* in synonymy with *E. mutica* var. *subvillosa.* Hemsley (1881) cited *C. galeottii* (A. Gray) Hemsl. in Guatemala, but all Central American material is determined here as *E. mutica* var. *microcephala.* Thus, *E. mutica* var. *subvillosa* is excluded from Central America.

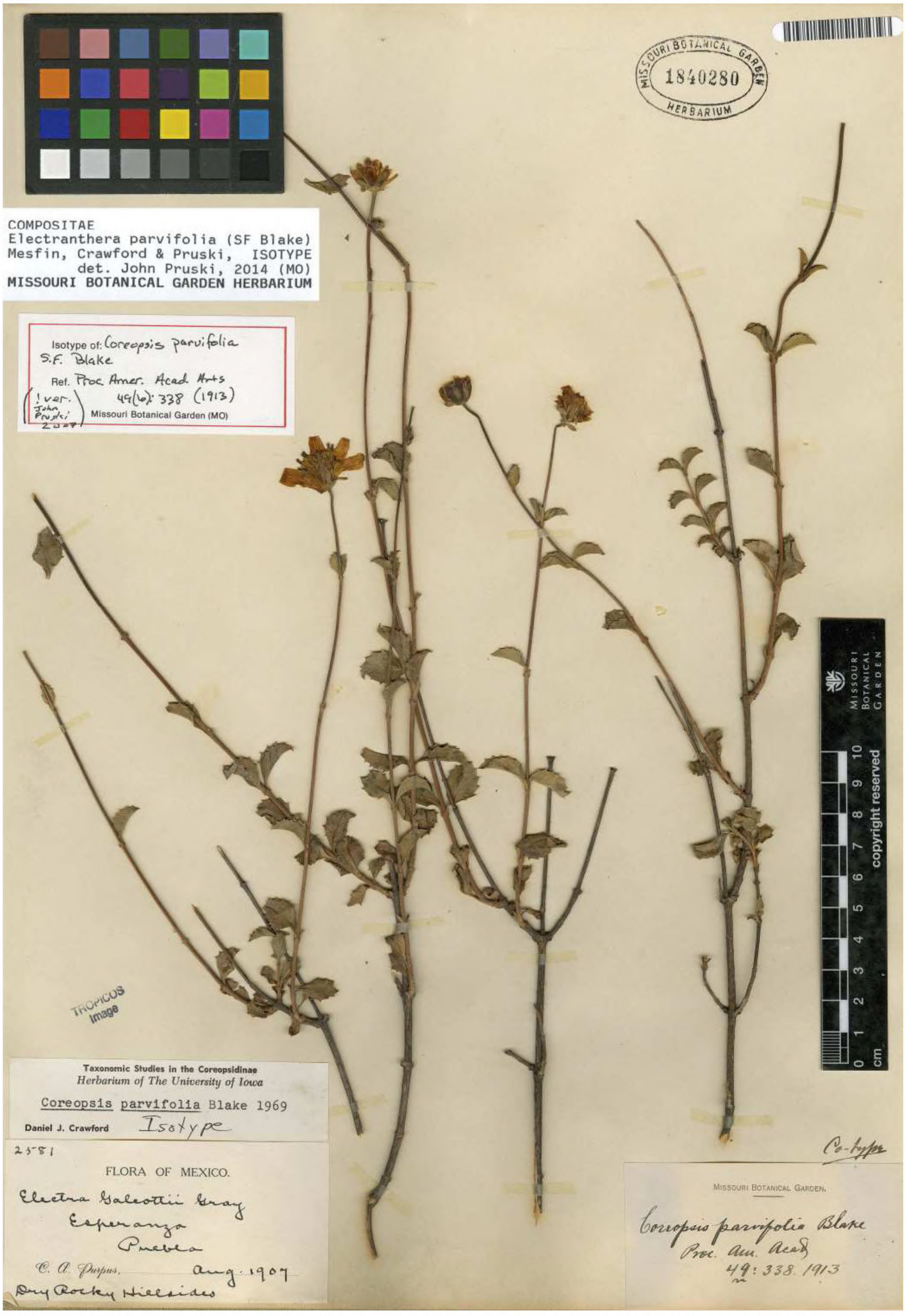

Figure 5. Isotype of *Coreopsis parvifolia* (≡ *Electranthera parvifolia*) (*Purpus 2581*, MO).

3. **ELECTRANTHERA PARVIFOLIA** (S.F. Blake) Mesfin, Crawford, & Pruski, **comb. nov.** *Coreopsis parvifolia* S.F. Blake, Proc. Amer. Acad. Arts 49: 338. 1913. *Electra parvifolia* (S.F. Blake) Mesfin & Crawford, Nord. J. Bot. 32: 89. 2014 [2013]. **TYPE: MEXICO. Puebla.** Esperanza, Aug 1907, *Purpus 2581* (holotype: GH; isotypes: F, MO, NY, UC, US). Figure 5.

Shrubs mostly 1–3 m tall; stems branched, subappressed or antrorse pilose distally, glabrate proximally; distal internodes usually much longer than leaves. **Leaves** undivided, petiolate; petiole 0.2–0.3 cm long; blade mostly 1–2.5 × 0.8–1.5 cm, ovate to orbicular, stiffly subsucculent, secondary veins usually 2–7 per side but not prominent, veins lucidus and sometimes falsely resembling glands, areolae dark, adaxial surface subappressed-puberulent, abaxial surface sparsely villous to glabrous, base cuneate to nearly obtuse, margins 4–5-serrate in distal half, teeth equally spaced, 0.5–1.5 mm long, mostly directed forward, apex broadly acute to obtuse or nearly rounded. **Capitulescence** monocephalous to paucicephalous open-cymose; peduncles 3–10 cm long, costate-angulate. **Capitula** 8–15 mm tall, to 25–45 mm wide across extended rays; involucre 8–11 mm long, campanulate; outer phyllaries 5–6 with 6th perhaps often merely an extreme distal peduncular bracteole closely subtending involucre, 3.9–6 × 1.8–3 mm, narrowly oblong to spatulate, narrower than and ca. 1/2–2/3 as long as inner phyllaries, appressed to slightly spreading, subcarnose, green, 3(–5)-nerved, lateral nerves submarginal, the sublateral veins not as long as laterals and medial, surfaces sparsely villous or more densely so at slightly noncontiguous and somewhat dilated base, margins sometimes ciliate, apex obtuse, sometimes callose-mucronulate; inner phyllaries 8–11 × 2–4.5 mm, obovate, scarious, drying with thin yellowish longitudinal bands between 9–11 pale brownish to reddish broad nerves, margins pale-hyaline, apex mostly obtuse; paleae linear-oblong, 3–5-nerved, glabrous, apex broadly acute. **Ray florets** 5 or 8; corolla limb 12–15 × to ca. 8 mm, ovate to oblong, 11–14-nerved, apex nearly truncate, teeth usually < 0.5 mm long. **Disk florets** 20–25; corolla 6.4–7.4 mm long, lobes 0.9–1.4 mm long; anthers 2.8–3.4 mm long; style branches 1.5–2 mm long, sterile appendage 0.4–0.5 mm long. **Cypselae** 6.5–8 × 2.2–3.2 mm, at least outer ones broadly elliptic to obovate in outline, few-costate; strictly epappose.

Representative collections. **MEXICO. Puebla.** *Crawford et al. 1246* (OS), *1251* (OS); *Dunn et al. 23341* (NY, TEX); *Olsen & Lane 357* (TEX); *Purpus 2581* (type collection: F, GH, MO, NY, UC, US). **Veracruz.** *Carrillo-Reyes y Cházaro 5426* (MO).

Distribution, elevation, and chromosome number. *Electranthera parvifolia* is a locally common narrow endemic known only from a few localities within about 100 km of each other in eastern Puebla and west-central Veracruz in eastern Mexico (basically from near Esperanza north to Cofre de Perote, as mapped in part by Turner 2010: 156, map 37), where it occurs mostly in rocky montane areas and pine-oak forests from 2300–2900 meters elevation; octoploid, $2n = 8x = 112$.

The outer phyllaries, ray corollas, paleae, and disk corollas of *Electranthera parvifolia* were illustrated as *C. parvifolia* by Mesfin Tadesse et al. (1995: figs. 1L, 2G, 3I, and 4B), with their illustration voucher being *Crawford 1251*; the same collection served as a voucher in Crawford (1982) and Mesfin Tadesse and Crawford (2014).

EXCLUDED NAME

Coreopsis buchii (Urb.) S.F. Blake, Contr. U.S. Natl. Herb. 22: 641. 1924 ≡ **Selleophytum buchii** Urb. (see Mesfin Tadesse and Crawford 2006).

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LITERATURE CITED

Bentham, G. and J.D. Hooker. 1873. Compositae. Pp. 163–533 *in* Genera Plantarum, vol. 2. London.

Blake, S.F. 1913. A redisposition of the species heretofore referred to *Leptosyne*. Proc. Amer. Acad. Arts 49: 335–345.

Blake, S.F. 1917. New and noteworthy Compositae, chiefly Mexican. Contr. Gray Herb. 52: 17–59.

Blake, S.F. 1924. New American Asteraceae. Contr. U.S. Natl. Herb. 22: 587–661 + pl. 54–63.

Blake, S.F., B.L. Robinson, and J.M. Greenman. 1926. Asteraceae. Aster Family. Pp. 1401–1641, *in* P.C. Standley, Trees and Shrubs of Mexico. Contr. U.S. Natl. Herb. 23: 1–1721.

Candolle, A.P. de. 1836. Prodromus systematic naturalis regni vegetabilis, vol. 5. Paris.

Crawford, D.J. 1970. Systematic studies on Mexican *Coreopsis* (Compositae). *Coreopsis mutica*: flavonoid chemistry, chromosome numbers, morphology, and hybridization. Brittonia 22: 93–111.

Crawford, D.J. 1972. The morphology and flavonoid chemistry of synthetic infraspecific hybrids in *Coreopsis mutica* (Compositae). Taxon 21: 27–38.

Crawford, D.J. 1976. Taxonomy of *Coreopsis* sect. *Pseudo-Agarista* (Compositae) in Mexico with additional comments on sectional relationships in Mexican *Coreopsis*. Brittonia 28: 329–336.

Crawford, D.J. 1981. A new variety of *Coreopsis mutica* (Compositae) from Mexico. Brittonia 33: 547–551.

Crawford, D.J. 1982. Chromosome numbers and taxonomic notes for Mexican *Coreopsis*, sections *Electra* and *Pseudoagarista* (Compositae: Heliantheae). Brittonia 34: 384–387.

Crawford D.J. and E.B. Smith. 1983. Leaf flavonoid chemistry of North American *Coreopsis* (Compositae): intra- and intersectional variation. Bot. Gaz. 144: 577–583.

Davidse, G. 2003. *Schismus*, Catalogue of New World Grasses (Poaceae): III. Subfamilies Panicoideae, Aristidoideae, Arundinoideae, and Danthonioideae. Contr. U.S. Natl. Herb. 46: 558–560.

Farr, E.R., J.A. Leussink, and F.A. Stafleu (eds). 1979. Index nominum genericorum (plantarum), vol. 1. *Aa – Epochium*. Reg. Veg. 100: xxvi + 1–630.

Gray, A. 1852. Plantae Wrightianae Texano-Neo-Mexicanae: An account of a collection of plants made by Charles Wright. Smithsonian Contr. Knowl. 3(5): 1–146 + pl. 1–10.

Hemsley, W.B. 1881. Compositae. Pp. 69–262, *in* E.D. Godman and O. Salvin (eds.), Biologia Centrali-Americana, Botany, vol. 2(7–10). London.

Jackson, B.D. 1893. Index Kewensis plantarum phanerogamarum, vol. 1. London.

Jansen, R.K., E.B. Smith, and D.J. Crawford. 1987. A cladistic study of North American *Coreopsis* (Asteraceae: Heliantheae). Pl. Syst. Evol. 157: 73–84.

Kimball, R.K. and D.J. Crawford. 2004. Phylogeny of Coreopsideae (Asteraceae) using ITS sequences suggests lability in reproductive characters. Molec. Phylog. Evol. 33: 127–139.

McVaugh, R. 1984. Compositae. Flora Novo-Galiciana 12: 1–1157.

McVaugh, R. 2000. Botanical results of the Sessé & Mociño Expedition (1787–1803): VII. A guide to relevant scientific names of plants. Hunt Institute for Botanical Documentation, Pittsburgh.

Mesfin Tadesse and D.J. Crawford. 1995. New synonyms in *Coreopsis* L. and notes on *C.* sect. *Pseudoagarista* (Compositae-Heliantheae). Compositae Newslett. 27: 11–30.

Mesfin Tadesse and D.J. Crawford. 2006. Resurrection of the genus *Selleophytum* (Asteraceae: Coreopsideae). Nord. J. Bot. 24: 161–165.

Mesfin Tadesse and D.J. Crawford. 2014 [2013]. The phytomelanin layer in traditional members of *Bidens* and *Coreopsis* and phylogeny of the Coreopsideae (Compositae). Nordic J. Bot. 32: 80–91. [The early view date of the electronic publication is 14 Oct 2013].

Mesfin Tadesse, D.J. Crawford, and E.B. Smith. 1995. Comparative capitular morphology and anatomy of *Coreopsis* L. and *Bidens* L. (Compositae), including a review of generic boundaries. Brittonia 47: 61–91.

Mort, M.E., C.P. Randle, R.T. Kimball, Mesfin Tadesse, and D.J. Crawford. 2008. Phylogeny of Coreopsideae (Asteraceae) inferred from nuclear and plastid DNA sequences. Taxon 57: 109–120.

Nash, D.L. and L.O. Williams. 1976. Flora of Guatemala: Compositae. Fieldiana, Bot. 24(12): x + 1–603.

Pfeiffer, L. 1874. Nomenclator botanicus, vol. 1, pars alterna. Kassel.

Pruski, J.F. 2012. Compositae of Central America–II. *Ortizacalia* (Senecioneae: Senecioninae), a new genus of lianas with comose style branches. Phytoneuron 2012-50: 1–8.

Pruski, J.F. 2015. Studies of Neotropical Compositae–X. Revision of the West Indian genus *Narvalina* (Coreopsideae). Phytoneuron 2015-31: 1–15.

Rzedowski, J. and G. Calderón de Rzedowski. 2008. Compositae tribu Heliantheae I (géneros *Acmella – Jefea*). Fl. Bajío 157: 1–344.

Sherff, E.E. 1936. Revision of the genus *Coreopsis*. Publ. Field Mus. Nat. Hist., Bot. Ser. 11: 279–475.

Sherff, E.E. and E.J. Alexander. 1955. Compositae-Heliantheae-Coreopsidinae. North American Flora, ser. 2, 2: 1–149.

Smith, E.B. 1975. The chromosome numbers of North American *Coreopsis* with phyletic interpretations. Bot. Gaz. 136: 78–86.

Sprengel, K. 1817. Anleitung zur Kenntniss der Gewächse. Halle.

Strother, J.L. 1999. Compositae - Heliantheae s.l. Fl. Chiapas 5: 1–232.

Turner, B.L. 1992. *Coreopsis mutica* var. *guerreroana* (Asteraceae), a new taxon from Mexico. Phytologia 73: 7–13.

Turner, B.L. 1996. A new variety of *Coreopsis mutica* (Asteraceae) from western Oaxaca. Phytologia 80: 291–294.

Turner, B.L. 2010. The Comps of Mexico. A systematic account of the family Asteraceae (Chapter 10: subfamily Coreopsideae [sic]). Phytologia Mem. 15: 1–224.